enhancements in many regions within the terrestrial magnetosphere. In particular, we investigate the ionospheric response to such disturbances as observed by close orbiting spacecraft. Data will be presented from the LENA imager on the IMAGE spacecraft, the TIDE instrument on Polar and the ion spectrometer on the four Cluster spacecraft. All the instruments observe outflow on the 18th April 2002, although the orbits of the spacecraft are such that the timings of the outflow are not simultaneous. Nevertheless, the magnetosphere is highly disturbed at this time due to the arrival of interplanetary shocks and the storm activity as a result. In this study we present the observations from the three spacecraft and make an attempt to place these observations into context with the large-scale Sun-Earth interaction which has taken place. The outflow events are most likely a result of the enhanced magnetospheric activity, though we try to relate the event to particular features observed in both the solar wind and the inner magnetosphere.

SA12A-09 1600h

Penetration Electric Fields and Magnetospheric Convection During the April 2002 Storm

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We present measurements of the cross-polar-cap potential drop and the extent and magnitude of the electric field penetration during the April 2002 storm, provided by ion drift measurements on three DMSP spacecraft. The cross-polar-cap potential drop exceeded 150 kV on four occasions near Dst minima on April 17, 18, 19, and 20. In the absence of significant shielding near the inner edge of the ring current, measurable electric field penetration to low L-values was observed, maximizing near the Dst minima. The auroral oval reached a minimum magnetic latitude near 50 degrees while substantial electric fields penetrated to below 40 degrees magnetic latitude. The potential drop equatorward/earthward of the auroral oval/electron plasma sheet was a sizable fraction of the total potential drop across the polar cap/magnetosphere during the main and early recovery phases of the storms, at times exceeding 60 kV. We discuss these results and their implications of the formation and decay of the storm time ring current.

SA12A-10 1615h

The Global Ionosphere During the April 17 to 20, 2002 Magnetic Storm

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The structure of the global ionosphere during the April 17 to 20, 2002 magnetic storm is investigated using a number of simulation techniques. The observations show that the daytime densities were reduced by a factor of 3 for three consecutive days within the continental US. Although they are in the same longitude sector, the East and West coasts of the US show differing patterns. The Northern and Southern hemisphere also behave differently, in spite of the fact that the storm is close to equinox. During most of the storm period, the Equatorial Appleton anomaly is reduced, both in strength and in width. The ionospheric assimilative model called PRISM was used to estimate the profiles of ionospheric density throughout the globe during the April 2002 magnetic storm. The inputs to PRISM are vertical Total Electron Content (TEC), F-region Maximum density and height, as well as DMSP data such as high-latitude particles and auroral boundaries. TIEGCM simulations of the ionosphere for these days were performed. We compare the output from the assimilative model with that from the TIEGCM simulation in order to explain the reasons for the agreements and disagreements between the theoretical simulation model, and the ionospheric assimilation model. To explain the behavior of the Equatorial anomaly, we examine the electrodynamics in the low-latitude region for the event.

SA12A-11 1630h

GUVI/TIMED Observations During the April 14-24, 2002 Storm

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The Global Ultraviolet Imager (GUVI) on the NASA Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED) spacecraft is a hyperspectral imager that operates in the far ultraviolet (110 to 180 nm). During the April storm GUVI observed changes in the observed radiance that can be interpreted in terms of changes in composition in the ionosphere and thermosphere (IT) and the coupled response of the IT system to forcing from outside the atmosphere.

In this paper we review the results of the ASPEN TIMEGCM runs and compare them to the GUVI observations. We will report on our analysis of the neutral composition measurements and the observed change that occured in response to external inputs. We will also report on our analysis of the GUVI observations of the nightside ionosphere. In those observations we see the clear signature of the interaction of the IT system as it responds to high latitude forcing.

URL: http://guvi.jhuapl.edu

SA12A-12 1645h

HALOE Observations of Perturbations in High Northern Latitude NO and Ozone During the April 2002 Solar Storm Episode

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The April 2002 solar storm event provides a unique opportunity to study the resulting effects on upper atmospheric constituents such as NO and ozone. Two sources may perturb these constituents. For a magnetic-storm-source, energetic particles collide with and dissociate nitrogen molecules in the lower thermosphere to produce excited nitrogen atoms which then combine with O to produce NO. The NO subsequently gets transported down to lower altitudes where it reacts with and thus destroys mesospheric and possibly stratospheric ozone. For a solar-particle-event-source, high-energy particles penetrate directly into the mesosphere, break apart nitrogen molecules and water vapor, creating NOx and HOx to destroy ozone in the middle atmosphere. We present perturbations in high northern latitude NO and ozone as measured by the Halogen Occultation Experiment (HALOE) aboard the Upper Atmosphere Research Satellite between April 20-27. HALOE observations show an order of magnitude increase in mesospheric NO and a factor of 2 decrease in mesospheric O3. We will also compare these observations with NASA GSFC 2D model computations.

SA21A MCC: Hall D Tuesday 0830h

Extracting Power From Multiple Rivers of Data I Posters *(joint with SH, SM)*

Presiding: **E Hildner,** NOAA Space Environment Center**; T Fuller-Rowell,** CIRES University of Colorado and NOAA Space Environment Center

SA21A-0419 0830h POSTER

Exospheric temperature formulation for use in atmospheric density models based on new data and proxies

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The exospheric temperature for the Earth's upper atmosphere is often specified by an empirical formulation for Jacchia-type neutral thermosphere density models. The Jacchia 1970 model, for example, uses an equation that was derived from a relationship between the 10.7 cm solar radio flux (F10.7) and observed satellite drag nearly 40 years ago. F10.7 is representative of solar coronal emissions. In the last few years, advances in two separate areas have converged to provide an enormous step forward in exospheric temperature/thermospheric density specification. First, information on the long term orbit evolution of a few key satellites over several solar cycles became available. Second, the E10.7 solar proxy, representative of both chromospheric and coronal solar emissions, was developed and compared with the F10.7 proxy for use in

specifying exospheric temperatures. Out of the combination of these two activities has emerged a new formulation of the Jacchia 1970 exospheric temperature equation that uses daily E10.7 and an 81-day averaged F10.7 to provide thermospheric densities significantly improved from those provided by the original Jacchia 1970 temperature equation. The comparison of the new temperature formulation with the older version is presented and the significance of this new technique for better understanding, describing, and predicting the space environment is discussed.

URL: http://SpaceWx.com

SA21A-0420 0830h POSTER

Analysis of Joule heating parameterizations

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Determination of a simple parameterization for Joule heating in the ionosphere is important in both data assimilation and large scale ionospheric satellite drag models. Recently parameterizations using either a combination of Polar Cap Index (PCI) and the Disturbance Storm Time Index (Dst) or solar wind inputs have been proposed for both the hemispheric and spatially dependent Joule heating. We develop statistics of the residuals from the PC/Dst and solar wind proxy driven parameterizations compared to AMIE derived heating results over a 55 day period.

These results are then compared to Joule heating parameterizations developed using the ap index, which is currently used in NASA satellite drag models. We also include examples of Joule heating parameterizations driven with the aa and AE indices. This analysis will allow us to compare the relative utility and ease of implementation of different Joule heating proxies.

SA21A-0421 0830h POSTER

Assimilation of Measurements from a Network of Fabry-Perot Interferometer Observatories for Real Time Modelling Applications: Problems and Possible Science Returns

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There exists presently a total of about 20 Fabry-Perot interferometer (FPI) observatories at various national and international locations around the globe dispersed between the polar and equatorial regions. These instruments operate on the principle of measuring the Doppler shifts and Doppler widths of atmospheric spectral lines emitted by metastable atomic species that are sufficiently long-lived in the mesosphere and thermosphere regions for local equilibrium to be attained before emission. Possible sources of these emissions are the layers of nightglow and dayglow emissions which originate from the production of active species as a consequence of the ionospheric chemistry of the upper atmosphere. At high latitudes the aurora generated by precipitating electrons or protons also represents a significant emission source. The determination of zonal and vertical wind components by these FPI observatories represents unique information concerning the dynamics of the upper atmosphere for both regions not available from other instrumental sources utilizing passive remote sensing principles. If these data products of temperature and winds for both regions could be assimilated within a reasonable elapse of time (perhaps one hour), these results would provide valuable constraints upon the bounds of modeling real-time parameters for thermospheric and mesospheric dynamics. The application of information technology can be readily envisioned to achieve the analysis of FPI data required for real time display and through transfer over the Internet network for data assimilation into global modeling codes. This paper would summarize the problems and science yields in achieving the assimilation of such measurements into the modeling framework envisioned.

SA21A-0422 0830h POSTER

Realistic, Low Latitude, F Region Vertical ExB Drifts Obtained From Magnetometer Observations

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The Ionospheric Forecast Model (IFM) will soon be operational at the Air Force Weather Agency (AFWA), Offutt AFB, Nebraska. IFM is a theoretically based model that calculates ion and electron densities as a function of altitude, latitude and local time, globally, in near real-time. The University Partnership for Operational Support (UPOS) has recently funded a study to demonstrate that the use of magnetometer-inferred ExB drift values as an input to IFM is significantly superior to the climatological drifts in specifying the low latitude F region ionosphere in the South American sector, day-to-day. The validation of this procedure compares observations from the Jicamarca Digisonde on the magnetic equator with the calculated ionospheric parameter, Nmax, from IFM. In addition, the calculated values of Total Electron Content (TEC) from IFM are compared with a network of ground-based GPS dual frequency receiver observations of TEC in the South American sector to demonstrate the improvement in ionospheric specification within +/- 35 degrees dip latitude of the magnetic equator. It is found that when realistic ExB drifts are incorporated into IFM rather than a climatological ExB drift pattern, the RMS error between calculated and observed Nmax values at the magnetic equator is significantly reduced. From 22% to 12%. The results of this study will be presented in detail.

SA21A-0423 0830h POSTER

On Using the Weimer Statistical Model for Real-Time Ionospheric Specifications and Forecasts

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The Weimer statistical model (*Weimer*, 2001) for the high-latitude convection pattern was tested with regard to its ability to produce real-time convection patterns. This work is being conducted under the polar section of GAIM (Global Assimilation of Ionospheric Measurements). The method adopted involves the comparison of the cross-track ion drift velocities measured by DMSP satellites with those calculated from the Weimer model. Starting with a Weimer pattern obtained using real-time IMF and solar wind data at the time of a DMSP satellite pass in the high-latitude ionosphere, the cross-track ion drift velocities along the DMSP track were calculated from the Weimer convection model and compared to those measured by the DMSP satellite. Then, in order to improve the agreement between the measurement and the model, two of the input parameters to the model, the IMF clock-angle and the solar wind speed, were varied to get the pattern that gives the best agreement with the DMSP satellite measurements. Four months of data (March, July, September, and December 1998) were used to test the Weimer model. The result shows that the agreement between the measurement and the Weimer model is improved by using this procedure. The Weimer model is good in a statistical sense, it was able to produce the large-scale structure in most cases. However, it is not good enough to be used for real-time ionospheric specifications and forecasts because it failed to produce a lot of the mesoscale structure measured along most DMSP satellite passes.

Reference

Weimer, D. R. , *J. Geophys. Res.*, *106*, 407,2001

SA21A-0424 0830h POSTER

Empirical Modeling of Ion composition in the Outer Ionosphere

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A new global empirical model of ion composition in the region of the outer ionosphere (altitude range of 500 to 2500 km) has been developed for the most important ions (O+, H+, He+, and N+). It is based on the model proposed by Triskova et al., 2002 and includes several improvements. The model relies on data sets from solar maxima and solar minima. To get model values for an arbitrary solar activity level, different interpolation/extrapolation techniques taking these two levels as anchor points are used. Relative/absolute ion density obeying first order influences has been approximated by a system of orthonormal functions at several fixed altitude ranges. Various functions including physical processes are tested for expression of the altitude dependence to obtain smooth profiles of the upper transition height. This model is compared with newly available data from the RPA instrument onboard the Intercosmos 24 satellite, and from the ion mass spectrometer onboard OGO 6.

SA21A-0425 0830h POSTER

A Local Empirical Model of the E and F Region Ionosphere Based on 30 Years of Millstone Hill Incoherent Scatter Radar Data

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Improved specifications and predictions of the ionosphere/thermosphere system are an important objective of the National Space Weather Program. As a contribution toward meeting this objective, we are developing a series of empirical models of the average behavior and variability of key parameters which characterize the ionosphere/thermosphere system. Here we present a local model of the E and F regions above Millstone Hill (42.6 N, 288.5 W) based on Millstone Hill Incoherent Scatter Radar data from 1970 to the present.

The model parameters are electron density, ion temperature, electron temperature, geomagnetic-field-aligned ion drift and electric field. Time resolution is one hour, seasonal resolution is one month, altitude coverage is 100-1000 km and altitude resolution ranges from 5 km in the lower E-region to 300 km in the upper F-region. The model includes solar flux (F10.7) and geomagnetic activity (Ap) dependencies. Software to recover model values as well as a Web interface to the model is available at http://www.openmadrigal.org.

SA21A-0426 0830h POSTER

The Analysis of TEC Data From the TOPES/Poseidon Mission

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The TEC data sets from the TOPEX/Poseidon mission (launched August 10, 1992) are now available from the NASA Physical Oceanography Distributed Active Center at JPL. These data sets have been analyzed to show the climatological TEC maps and the geomagnetic and solar activity effects on the TEC climatology. The currently available data sets cover from the middle of 1992 to 2001, which is almost a full solar cycle through the cycle 22 to 23, and hence, the data sets can show the TEC variation with the solar flux (F10.7 cm) change. The binning has been performed by season (equinox, June and December solstice), geomagnetic activity (low, moderate, and high Kp), and solar flux (low and high F10.7 cm flux) with 1×1^{o} bins in geomagnetic latitude and magnetic local time. The annual and semiannual anomalies seem to be quite clear, but our analysis does not show the seasonal anomaly because of the longitudinally averaged binning. The equatorial anomaly is very clear in the TEC maps and they show its variations with the geomagnetic and solar activity. The effects of the solar flux are quite clear. Compared with the low solar flux condition (F10.7 $<$ 120), the TEC values at high solar flux (F10.7 $>$ 120) are much larger (about 100%) and the equatorial anomaly lasts longer, up to midnight. On the other hand, even though the TEC maps show the general tendency of the ionospheric response to the change of geomagnetic conditions, it was not as clear as the solar activity effects, probably because the Kp bins dont represent real storm periods. These results and a comparison to the previous TOPEX analysis (*Codrescu et al.*, 1999) will be presented.

Reference

Codrescu, M. V., et al., *J. Atmos. Solar-Terr. Phys.*, *61*, 281-298, 1999.

SA21A-0427 0830h POSTER

The Impact of GPS TEC Data on the Global Assimilative Ionosphere Model (GAIM)

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As the number of ground and space-based receivers tracking the global positioning system (GPS) steadily increases, and ionospheric remote sensing data such as measurements of airglow become available, it is becoming possible to monitor changes in the ionosphere continuously and on a global scale with unprecedented accuracy and reliability. This is best achieved by means of data assimilation using a 4-dimensional (4DVAR) scheme or a recursive statistical estimation approach such as the Kalman filter. Our presentation will review the development of a Global Assimilative Ionospheric Model (GAIM) at the University of Southern California and the Jet Propulsion Laboratory capable of assimilating various types of data including ground and flight GPS total electron content (TEC), ionosondes and airglow measurements. The recursive estimation technique is used to the determination of electron density with a relatively short data assimilation cycle of 15 minutes. The 4DVAR technique is used to estimate the ionospheric driving forces with a longer data assimilation cycle of 2 hours. The optimized ionospheric state variables and driving forces are then used in the forward model to produce new forecasts for ionospheric variables. The evaluation of either approach is first made through Observation System Simulation Experiments (OSSE) in which simulated measurements derived from forward model output are used. Our presentation will describe GAIM and examine its analyses by assimilating GPS TEC data from nearly 100 global ground stations and the currently operating GPS flight experiments, CHAMP, SAC-C and IOX. A series of GAIM retrievals will be presented and validated by comparisons to: vertical TEC data from the TOPEX altimeter, slant TEC data from ground GPS sites not used in the assimilation, and a global network of ionosondes.

SA21A-0428 0830h POSTER

The Conical Fit Approach to Modeling Ionospheric Total Electron Content

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The Global Positioning System (GPS) can be used to measure the integrated electron density along raypaths between satellites and receivers. Such measurements may, in turn, be used to construct regional and global maps of the ionospheric total electron content (TEC). Maps are generated by fitting measurements to an assumed ionospheric model. The problem is inherently four-dimensional: each slant TEC measurement depends upon the position and orientation of its raypath. For example, if we define the ionospheric pierce point (IPP) of a raypath to be the point where the raypath intersects a reference ionospheric height, we can treat slant TEC measurements as functions of four parameters: the sublatitude and sublongitude of the IPP and the raypath azimuth and elevation angles at the IPP.

Current slant TEC models often simplify the problem by reducing its dimensionality. A typical strategy is to associate a given slant GPS measurement with the vertical TEC value at the IPP. The slant-to-vertical conversion (i.e., the mapping function) is treated as a known function of elevation angle and other model variables. Two types of error restrict the accuracy of such models: (1) error associated with the choice of model mapping function, and (2) error arising from the neglect of horizontal gradients of the electron density along the raypath. Defining a mapping function requires assuming a predetermined form for the unknown height variation of the electron density profile. For example, the popular thin-shell model relies on the rather crude assumption that the electron density is non-negligible only in the vicinity of the ionospheric reference height. A consequence of neglecting horizontal density gradients is that distinct measurements, which share a common IPP, can produce inconsistent estimates of vertical TEC. Even when the estimates agree, they can still be in error due to an incorrect choice of ionospheric reference height.

This paper describes an alternative model of slant TEC measurements that retains the full four-dimensional character of the problem. The key to this approach is to obtain distinct sets of fit parameters for groups of measurements that each share a single satellite or a single receiver. Consider, for example, a set of measurements from a group of receivers that are all looking at the same satellite. The raypaths of these measurements define a cone whose vertex is the position of the satellite (hence, we designate our approach to be a "conical fit"). Fit parameters are retrieved for a cone assuming linear deviations of the electron density from local spherical symmetry. Maps of vertical TEC over a specified region may be generated by first solving for fit parameters associated with multiple cones, each with a different receiver or satellite at its vertex. Note that the fit for any individual cone is strictly a two dimensional problem; only when multiple cones are fit simultaneously does the four-dimensional nature of the problem reemerge.

We present results comparing the accuracy of this approach with that achieved using the thin-shell model. The accuracy of each approach is assessed using a missing-measurement analysis, i.e., the value of a measurement excluded from the fit is compared to the value predicted by the model. We assess accuracy using data sets from both quiet days and days when the ionosphere is disturbed. Furthermore, we assess the dependence of accuracy on latitude by comparing results based upon data sets from Brazil and the United States.

SA21A-0429 0830h POSTER

Scintillation Observations With the Ionospheric Occultation Experiment (IOX)

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The Ionospheric Occultation Experiment (IOX) is a dual-frequency GPS receiver with a single Earth-limb viewing antenna. Ionospheric remote sensing is possible during occultation events in which the line of sight to a GPS satellite being tracked by IOX sets through the Earth's limb. IOX is in a 67°inclination, 800 km altitude orbit, enabling it to make ionospheric measurements at all local times under near-solar maximum conditions over the course of its mission. IOX has been making routine measurements of occulting GPS satellites since the latter part of November 2001. Signal-to-noise (SNR) fluctuation observations associate the with GPS C/A code on the L1 frequency are identified as due to ionospheric scintillation by the geographic (equatorial/high latitude) and local time (post-sunset) morphologies. A preliminary analysis of scintillation climatology inferred from the IOX measurements will be presented and compared to a model of scintillation occurrence.

SA21B MCC: Hall D Tuesday 0830h

Tracing the Sun-Earth Connection Into the Upper Atmosphere: Study of the April 2002 Events III Posters

(joint with SH, SM)

Presiding: **T Zurbuchen,** University of Michigan**; M G Mlynczak,** NASA Langley Research Center**; R P Lin,** University of California, Berkeley**; D N Baker,** University of Colorado, Boulder

SA21B-0430 0830h POSTER

UVCS Observations of the 21 April 2002 CME

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In conjunction with the Max Millenium campaign, the UVCS slit was placed at 1.53 solar radii when the X-class flare in Active Region 9906 occurred. At 1:05 UT the streamer that dominated the pre-flare emission began to fade, and the streamer was violently disrupted, with Doppler shifts reaching -850 and +500 km/s. We discuss the physical parameters of the pre-CME streamer, the nature of the streamer blowout, and a feature visible in the line of [Fe XVIII] possibly associated with magnetic reconnection.

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Extreme Ultraviolet Variability of the Large Solar Flare on April 21, 2002 and the Terrestrial Photoelectron Response

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The near-simultaneous observations of the solar extreme ultraviolet (EUV) irradiance and terrestrial photoelectron distribution during and after the large solar flare on April 21, 2002 provide for a distinctive study of the effects that a solar flare can have on Earth's upper atmosphere. The solar EUV irradiance from 0.1-195 nm was measured by the Solar EUV Experiment (SEE) aboard the NASA Thermosphere, Ionosphere, Mesosphere, Energetics, and Dynamics (TIMED) satellite. The terrestrial photoelectron distribution from 50-1000 eV was measured by the Fast Auroral Snapshot (FAST) energetic electron sensor. The variations of the solar EUV irradiance from the X class flare at 2 UT on April 21, 2002 range from more than a factor of 8 for the X-ray emissions to less than 10% at longer EUV wavelengths. The spectral shape of this flare is similar to that predicted for the Bastille Day 2000 flare. Most of the solar irradiance variation is in the X-ray range and for coronal emissions. The photoelectron distribution changed by a factor of about 10 for the high-energy Auger electrons and by very little for the low-energy thermal electrons. Modeling of the photoelectron distribution using the measured solar EUV irradiance will also be presented.

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Thermospheric and Ionospheric Response to the Solar Flares of April 2002 as Observed by the TIMED Global UltraViolet Imager (GUVI)

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